A CRITICAL COMPARISON OF DNS VERSUS RANS MODEL RESULTS ON AN HPT BLADE FOR A SMALL ENGINE

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Abstract

In this work, we present preliminary Direct Numerical Simulation (DNS) results of compressible flow past a High-Pressure Turbine (HPT) blade of an experimental Small Turbofan Engine (STFE) designed by Defence Research and Development Organisation (DRDO), Gas Turbine Research Establishment (GTRE) [1, 2]. These DNS results are then compared with the results obtained by two well-known industry standard RANS models, namely the Realizable κ-ε (RKE) and the Shear Stress Transport (SST) models along with a hybrid LES-RANS (LNS) model. All the simulations are carried out at inlet Reynolds number of 152,000 (based on chord length of the blade), and inlet Mach number of 0.16 with zero degree of angle of incidence. DNS results are obtained with approximately 94 and 129 million mesh cells. For RANS and LNS calculations, we have used 0.16 and 3.54 million mesh cells respectively. Surface pressure distributions obtained from DNS are closer to experimental values compared to RANS and LNS. Also, DNS predicts flow separation near the trailing edge when a grid is refined from 94 x 10^6 to 129 x 10^6 cells, whereas present RANS and LNS simulations fail to capture separation. Interestingly, mean surface pressure obtained from DNS with two different mesh sizes vary mostly near the separation and trailing edge region, where the experimental data points are not available.

Keywords: Gas Turbine, HPT, DNS, RANS, HPC, GPU